Evaluation of Mortality Rates of Hanover, Kansas—1999-2007

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Background

The Commodity Credit Corporation (CCC), an agency of the U.S. Department of Agriculture (USDA), operated a grain storage facility on approximately 6.5 acres in Hanover, Kansas from 1950 to the early 1970s. During its operations, a grain fumigant known as 80/20, named for its composition of 80% carbon tetrachloride and 20% carbon disulfide, was used at the facility. The former facility site was developed as residential property in the mid-1970's.

Carbon tetrachloride has been detected in the groundwater and soil beneath the former CCC/USDA facility. The contaminant was also detected in indoor air samples collected at several homes built on the former facility. Some citizens of Hanover, Kansas are concerned that potential exposure to environmental contaminants from the site may be related to a high death rate in their city.

We conducted a mortality study of Hanover, Kansas to analyze the death rate and to characterize causes of death.

Methods

Data for all deaths among residents of Hanover from 1999-2007 were obtained from the Kansas Department of Health and Environment's Office of Vital Statistics and imported into a Microsoft® Excel spreadsheet.

Crude and cause-specific death rates for Hanover were calculated. Age-adjusted death rates were calculated using the 2000 U.S. Census population standard and compared with age-adjusted death rates for Kansas as a whole. Mortality rates for all causes were calculated as deaths per 1,000 persons. Disease-specific mortality rates (i.e. cancer, heart disease) were calculated as deaths per 100,000 persons.

Results

When compared to the population of the entire state of Kansas, the city of Hanover has a higher proportion of persons over the age of 65 (Table 1). This includes 38% higher proportion of those aged 65-74 years, 58% higher proportion of those aged 75-84 years and 74% higher proportion of those aged 85 years of age or older.

Proportion of Population by Age Group, 2000.

Table 1.

	Hanover		State of Kansas	
Age Groups	**Number**	**%**	**Number**	**%**
0-4	35	5.4	188,708	7.0
5-14	78	11.9	399,592	14.9
15-24	76	11.6	400,285	14.9
25-34	61	9.3	348,853	13.0
35-44	84	12.9	420,351	15.6
45-54	76	11.6	354,149	13.1
55-64	54	8.3	220,253	8.2
65-74	68	**10.4**	175,916	**6.5**
75-84	74	**11.3**	128,543	**4.8**
85+	47	**7.2**	51,770	**1.9**
Total Population	653		2,688,420	

The crude death rate for Hanover from 1999-2007 was 21.3 deaths per 1,000 population per year [(125 / 5,877)*1,000 = 21.3] (Table 2).

Crude Age-Specific Death Rates for Hanover, 1999-2007.

Table 2.

Age Group	Number of Deaths	Sum of Hanover Population 1999-2007	Crude Age-Specific Death Rate (per 1,000)
0-4	1	315	3.2
5-14	0	702	0
15-24	2	684	2.9
25-34	0	549	0
35-44	1	756	1.3
45-54	2	684	2.9
55-64	2	486	4.1
65-74	18	612	29.4
75-84	31	666	46.6
85+	68	423	160.8
Total	125	5,877	**21.3**

However, in order to accurately compare the death rate to the entire state of Kansas we must take the age distribution of the population of Hanover into consideration. This is accomplished by direct age-adjustment (Table 3).

Direct Age-Adjustment for Hanover 1999-2007; All Causes of Death.

Table 3.

Age Group	Hanover Age-Specific Death Rate (per 1,000)	2000 U.S Population	Percentage of U.S Population by Age	Number Expected Deaths
0-4	3.2	19,175,798	7	60,787
5-14	0	41,077,577	15	0
15-24	2.9	39,183,891	14	114,417
25-34	0	39,891,724	14	0
35-44	1.3	45,148,527	16	59,596
45-54	2.9	37,677,952	13	110,020
55-64	4.1	24,274,684	9	99,769
65-74	29.4	18,390,986	7	540,879
75-84	46.6	12,361,180	4	575,413
85+	160.8	4,239,587	1	681,556
Total		281,421,906		2,242,437

The direct age-adjusted death rate for Hanover is 7.97 deaths per 1,000 population per year [(2,242,437 / 281,421,906)*1,000].

We can now compare both the crude and age-adjusted death rate for Hanover to the entire state of Kansas (Table 4).

Death Rate Comparison, 1999-2007.

Table 4.

	Crude Death Rate* (95% CI)†	**Age-Adjusted Death Rate* (95% CI)†**
Hanover	21.3 (17.6, 25.0)	7.97 (6.6, 9.4)
Kansas	9.0 (8.95, 9.02)	8.19 (8.15, 8.22)

* Per 1,000 people
† 95% Confidence Interval

Initially, the crude death rate (21.3 per 1,000) for all causes in Hanover appears to be much higher than for the state of Kansas (9.0 per 1,000). However once we adjust for age, the death rate for Hanover decreases to 7.97 per 1,000. This rate is lower than the age-adjusted death rate (8.19 per 1,000) for all causes of death in the entire state of Kansas.

Indirect age-adjustment allows us to calculate the number of deaths that we would expect in Hanover if the population in Hanover were dying at the same rates by age as the state of Kansas. The end result is the expected number of deaths in Hanover (Table 5).

Indirect Age-Adjustment for Hanover 1999-2007; All Causes of Death.

Table 5.

Age Group	**Sum of Population 1999-2007**	**Kansas 2007 Age Specific Death Rates**	**Number Expected Deaths in Hanover**
0-4	315	0.00197	0.62
5-14	702	0.000155	0.19
15-24	684	0.000789	0.54
25-34	549	0.000966	0.53
35-44	756	0.0015	1.13
45-54	684	0.00476	3.26
55-64	486	0.0111	5.39
65-74	612	0.01982	12.13
75-84	666	0.05211	34.71
85+	423	0.16189	68.48
Total	5,877		126.98

We would expect 127 total deaths from 1999-2007 in Hanover. The total expected deaths in Hanover from 1999-2007 (n=127) are compared to the actual deaths (n=125) from the same time period. The standardized mortality ratio, or SMR, is the ratio of actual deaths/expected deaths. The SMR is 0.98 (125/127). A ratio of approximately 1 indicates that the number of actual deaths equals that of the expected deaths. We are able to calculate an indirectly standardized death rate for Hanover of 8.8 by multiplying the SMR (0.98) by the crude death rate for the state of Kansas (9.0).

Next we will examine the causes of death for Hanover compared to the state of Kansas (Table 6).

Top Five Causes of Death, 1999-2007.

Table 6.

	Hanover		Kansas	
	Number	**%**	**Number**	**%**
1. Heart Disease	30	24.0	57,101	25.9
2. Cancer	16	12.8	47,987	21.8
3. Stroke	14	11.2	15,236	6.9
4. Chronic Lower Respiratory Disease (CLRD)	7	5.6	12,868	5.8
5. Septicemia	4	3.2	2,507	1.1

The top five causes of death in Hanover are heart disease, cancer, chronic lower respiratory disease (CLRD), and septicemia (bacterial infection of the bloodstream). This closely follows the top five causes of death in Kansas with the exception of Alzheimer's disease as the number five cause of death state-wide. The proportion (percent) of disease-specific cause of death was determined by taking the number of deaths and dividing by the total deaths in all categories from 1999-2007 (Hanover=125, Kansas=220,285).

In order to compare the disease-specific death rates between Hanover and the entire state, we must perform the same calculations as we did for all causes of death. We will start with the number one cause of death in Hanover, heart disease (Table 7).

Direct Age-Adjustment for Hanover 1999-2007; Heart Disease.

Table 7.

Age Group	**Hanover Age-Specific Death Rate (per 100,000)**	**2000 U.S Population**	**Percentage of U.S Population by Age**	**Number Expected Deaths**
0-4	0	19,175,798	7	0
5-14	0	41,077,577	15	0
15-24	0	39,183,891	14	0
25-34	0	39,891,724	14	0
35-44	97.6	45,148,527	16	0
45-54	299.4	37,677,952	13	0
55-64	205.8	24,274,684	9	49,948
65-74	980.4	18,390,986	7	180,304
75-84	1,051.1	12,361,180	4	129,922
85+	3,782.5	4,239,587	1	160,363
Total		281,421,906		520,537

The direct age-adjusted death rate of heart disease in Hanover is 185 deaths per 100,000 population per year [(520,537 / 281,421,906)*100,000]. We can now compare this to the entire state of Kansas (Table 8.).

Heart Disease Death Rate Comparison, 1999-2007.

Table 8.

	Crude Death Rate* (95% CI)†	**Age-Adjusted Death Rate* (95% CI)†**
Hanover	510.5 (328,693)	185.0 (119,251)
Kansas	232.9 (231,235)	207.5 (206,209)

* Per 100,000 people
† 95% Confidence Interval

Initially, the crude death rate (510.5 per 100,000) for heart disease in Hanover appears to be much higher than for the state of Kansas (232.9 per 100,000). However once we adjust for age, the death rate for Hanover decreases to 185 per 100,000. This rate is lower than the age-adjusted death rate (207.5 per 100,000) for heart disease for the entire state of Kansas.

Next we will perform the same calculations for cancer (Table 10).

Direct Age-Adjustment for Hanover 1999-2007; Cancer

Table 10.

Age Group	**Hanover Age-Specific Death Rate (per 100,000)**	**2000 Kansas Population**	**Percentage of U.S. Population by Age**	**Number Expected Deaths**
0-4	0	19,175,798	7	0
5-14	0	41,077,577	15	0
15-24	0	39,183,891	14	0
25-34	0	39,891,724	14	0
35-44	0	45,148,527	16	0
45-54	0	37,677,952	13	0
55-64	0	24,274,684	9	0
65-74	490.2	18,390,986	7	90,153
75-84	450.5	12,361,180	4	55,681
85+	2,364	4,239,587	1	100,224
Total		281,421,906		246,058

The direct age-adjusted death rate of cancer for Hanover is 87 deaths per 100,000 population per year [(246,058 / 281,421,906)*100,000]. We can now compare this to the entire state of Kansas (Table 11).

Cancer Death Rate Comparison, 1999-2007.

Table 11.

	Crude Death Rate* (95% CI)†	Age-Adjusted Death Rate* (95% CI)†
Hanover	272 (139,405)	87 (45,130)
Kansas	196 (194,198)	186 (184,187)

* Per 100,000 people
† 95% Confidence Interval

Initially, the crude death rate (272 per 100,000) of cancer in Hanover appears to be higher than for the state of Kansas (196 per 100,000). Once we adjust for age, the death rate for Hanover decreases to 87 per 100,000. This is lower than the age-adjusted death rate for Kansas of 186 per 100,000.

Next we will perform the same calculations for stroke (Table 12).

Direct Age-Adjustment for Hanover 1999-2007; Stroke

Table 12.

Age Group	Hanover Age-Specific Death Rate (per 100,000)	2000 Kansas Population	Percentage of U.S. Population by Age	Number Expected Deaths
0-4	0	19,175,798	7	0
5-14	0	41,077,577	15	0
15-24	0	39,183,891	14	0
25-34	0	39,891,724	14	0
35-44	0	45,148,527	16	0
45-54	0	37,677,952	13	0
55-64	0	24,274,684	9	0
65-74	163	18,390,986	7	30,051
75-84	751	12,361,180	4	92,808
85+	1,891	4,239,587	1	80,183
Total		281,421,906		203,042

The direct age-adjusted death rate of stroke for Hanover is 72 deaths per 100,000 population per year [(203,042 / 281,421,906)*100,000]. We can now compare this to the entire state of Kansas (Table 13).

Stroke Death Rate Comparison, 1999-2007.

Table 13.

	Crude Death Rate* (95% CI)†	Age-Adjusted Death Rate* (95% CI)†
Hanover	272 (139,405)	72 (34,110)
Kansas	62 (61,63)	54.5 (54,55)

* Per 100,000 people
† 95% Confidence Interval

Initially, the crude death rate (272 per 100,000) of stroke in Hanover appears to be much higher than for the state of Kansas (62 per 100,000). Once we adjust for age, the death rate for Hanover decreases to 72 per 100,000. This is much closer to the age-adjusted death rate for Kansas of 54.5 per 100,000.

Discussion

Mortality rates, or death rates, are often used as a measure of health status for a population. Many factors affect the risk of death, including age, race, gender, occupation, education, and income. By far the strongest of these factors affecting the risk of death is age. Populations often differ in age composition. A "young" population has a higher proportion of persons in the younger age groups, while an "older" population has a higher proportion in the older age groups. Therefore, it is important to control for differences among the age distributions of populations when making comparisons among death rates to assess the relative risk of death.

The city of Hanover has a higher proportion of its population 65 years of age and older than the entire state of Kansas. Although the crude death rate for Hanover (21.3 per 1,000) appears to be much higher than the entire state of Kansas (9.0 per 1,000), once we adjust for age, the death rate of Hanover decreases to 7.97 per 1,000 and is lower than the state. The age-adjusted death rate for Hanover is not encompassed in the 95% confidence interval for the age-adjusted death rate for Kansas. This may be due to the small number of deaths in Hanover. Small numbers can increase the likelihood of random error.

In order to compensate for potential error due to the small number of deaths, we calculated an indirect age-adjusted death rate to determine the number of expected deaths in Hanover if the if the population had the same age distribution as the state of Kansas. The total expected deaths in Hanover from 1999-2007 (n=127) are compared to the actual deaths (n=125) from the same time period. The standardized mortality ratio is 0.98 (125/127). A ratio of approximately 1 indicates that the number of actual deaths equals that of the expected deaths.

The crude death rates for heart disease, cancer, and stroke in Hanover appeared much higher than the state. However, once adjusted for age, death rates for all three decreased; the age-adjusted death rate for cancer in Hanover is lower (87 per 100,000) than for the state (186 per 100,000). The age-adjusted death rate for heart disease in Hanover is 185 per 100,000 which is lower than the age-adjusted rate of 207.5 per 100,000 for Kansas.

The age-adjusted death rate for stroke in Hanover is 72 per 100,000. Although this rate appears to be higher than the age-adjusted rate of 54.5 per 100,000 for Kansas, the 95% confidence interval (34, 110) encompasses the age-adjusted death rate for Kansas of 54.5. Therefore, we would not consider the difference between the two rates to be significant.

In conclusion, once adjusted for age, the death rates in Hanover are similar to the entire state of Kansas.